SECTION 34 11 32

RESILIENT TIES

PART I - GENERAL

1.01 SECTION INCLUDES

A. Standard Resilient Ties (RT)

B. Special Trackwork Resilient Ties (SPRT)

1.02 RELATED SECTIONS

A. Refer to Section 34 05 17 - Common Work Results for Trackway, for related requirements.

1.03 MEASUREMENT AND PAYMENT

A. General: Miscellaneous track materials will not be measured separately for payment. All costs in connection therewith will be considered as included in the applicable Contract lump sum price or the Contract unit price per linear foot for trackwork of the different types indicated as listed in the bid item in the Bid Schedule of the Bid Form.

1.04 REFERENCES

A. American Railway Engineering and Maintenance of Way Association (AREMA):

AREMA Manual.

B. American Society for Testing and Materials (ASTM):

1.	ASTM C39/C39M	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
2.	ASTM C78	Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).
3.	C192/C192M	Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
4.	ASTM D412	Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.
5.	ASTM D573	Standard Test Method for Rubber-Deterioration in an Air Oven.
6.	ASTM D1149	Standard Test Method for Rubber Deterioration-Surface Ozone Cracking in a Chamber.
7.	ASTM D2240	Standard Test Method for Rubber Property-Durometer Hardness.

C. Precast/Prestressed Concrete Institute (PCI):

PCI MNL 116	Manual for Quality Control for Plants and Production of Structural Precast Concrete Products.

1.05 SUBMITTALS

A. Refer to Section 01 33 00 - Submittal Procedures, and Section 01 33 23 - Shop Drawings, Product Data, and Samples, for submittal requirements and procedures.

B. Refer to Section 34 05 17 - Common Work Results for Trackway, for additional submittal requirements.

C. Refer to Section 34 11 37 - Direct Fixation Fasteners, for additional testing requirements.

D. Provide additional submittals as required herein.

1.06 RT AND SPRT SUBMITTAL

A RT and SPRT shall consist of independent precast concrete blocks, suitably reinforced and incorporate two rail fastening shoulders and inserts for third rail insulator assemblies and SPRT baseplate anchoring. The proposed RT and SPRT system shall permit individual lateral adjustment of each rail, along with the third rail, using replaceable shims.

B. Separate submittals are required for RT's and SPRT's

C. Submit detailed shop drawings indicating the following:

1. Dimensional details of RT's and SPRT's showing plan, elevation, and cross sections. Include concrete strength and material specifications.

2. Location and spacing of reinforcement.

3. Dimensions and tolerances and location of rail fastening components for rail and rail joints, turnout plates and contact rail support bracket inserts.

4. Plans and samples to demonstrate conformance with the track tolerance requirements.

5. Submit three samples to the Engineer within 90 days following award of the Contract, of complete all various rail fasteners, including embedded shoulders, spring clips, insulators, tie pads, and contact rail support bracket inserts for review by the Engineer.

6. Recommendation for handling, transporting, and stacking of ties.

7. Submit list of sources proposed by the Contractor to obtain materials requiring approval, certifications, or testing.

1.07 RT AND SPRT QUALITY ASSURANCE AND CONTROL

A. Submittals:

1. RT and SPRT assembly drawings.

2. Detailed shop drawings and technical specifications for all RT and SPRT components.

3. Material certificates demonstrating tat the RT and SPRT block pads are made of natural rubber or an equivalent material approved by the Engineer and permitting to fulfill all the requirements herein.

4. Evidence satisfactory to the Engineer that the block pad design will guarantee that the performance of the proposed RT and SPRT system will not be negatively affected by the unavoidable ingress of water into the rubber boots during revenue service.

5. Material certificates demonstrating tat the RT and SPRT rubber boots are made of SBR and that the SBR content is at least 50 percent.

6. Evidence satisfactory to the Engineer that the internal rubber boot wall design will be such that a 0.02 inch gap between the rubber boot and the concrete block is maintained during construction, thereby allowing the concrete block to freely move downward as the block pad deflects under load during revenue service.

7. Evidence satisfactory to the Engineer that the rubber boot wall design will be such that replacing the original rubber boots with maintenance rubber boots having thinner walls will permit to achieve the specified 1 inch lateral adjustment of the RT and SPRT units without compromising the long term performance of the system.

8. Calculations of the concrete block strength, track modulus and maximum pressure per area exerted by the RT and SPRT units against the encasement concrete, both vertically and laterally, and a justification that the resulting values are compatible with the axle load, train speed and track curvature conditions prevailing on the project.

9. A description of how the proposed RT and SPRT system will be installed and permit to achieve the performance criteria and dimensional tolerances specified for the completed track in terms of track gauge, rail cant, horizontal and vertical track alignment, superelevation in curves and future vertical and lateral track adjustment.

10. Production testing plan in accordance with the requirements herein.

11. Quality assurance plan.

C. Qualification Testing

1. All design qualification testing on the cross tie and fastener assembly shall be performed by an approved independent laboratory that is staffed, equipped, and experienced to perform the specified tests.

2. All daily production quality control testing shall be performed in accordance with the approved Test Program Plan.

3. The Contractor shall supply a minimum of sixteen independent RT and SPRT units to be tested. These RT and SPRT units shall be manufactured in the same manner as the contractor plans to use for production runs. From the lot of sixteen RT and SPRT units so produced the Engineer shall select five units at random to be subjected to qualification testing. If any RT and SPRT unit fails to meet any of the testing requirements assigned to it, another unit shall be selected from the lot by the Engineer and the corresponding tests shall be repeated. A second failure shall require the production of a new lot of sixteen RT and SPRT units and the performance of another complete series of qualification tests.

4. The RT and SPRT units selected for testing shall be permanently marked with identifying numbers in accordance with the following sequence: A1, B1, C1, D1 and E1 for first iteration of tests and A2, B2, C2, D2 and E2 for second iteration of tests.

5. The testing sequence shall be as presented in the qualification test matrix shown in Figure 1.

6. A RT and SPRT unit, fully assembled but not embedded in concrete, shall be aged in an air oven for a period of 70 hours at a temperature of 212 degrees F (or for a period of 336 hours at 160 degrees F if it comprises one or more natural rubber components) in accordance with ASTM D573, Accelerated Aging of Vulcanized Rubber by the Oven Method. EVA rail pads shall be exempt from this test.

7. Before assembly, the metal parts and elastomers shall be hand cleaned and wiped dry. They shall be assembled as shown in the approved shop drawings and installation description. The test configuration shall simulate fully installed embedded RT and SPRT unit conditions, except where specifically stated, and shall consist of two RT and SPRT units on 30 inch centers with a piece of the same rail as specified for the project that is at least 42 inches long assembled to the RT and SPRT units. The minimum encasement concrete depth below the embedded RT and SPRT units shall be 2 inches. The perimeter of the encasement concrete shall be located at least 20 inches horizontally from the nearest point of an embedded RT and SPRT unit. Any forms shall be removed prior to testing. The embedment concrete shall attain its full compressive strength prior to initiation of testing. The embedment concrete shall have a compressive strength of no less than 4,000 psi in accordance with ASTM C39/C39M .

8. Figure 2 illustrates a typical test assembly.

9. Vertical load test

    a. Prior to the test, a minimum of ten 24,000 pound vertical loading cycles shall be applied downward at the center of the rail head midway between the RT and SPRT units to ensure the proper seating of all components. The vertical position of the rail head after the seating procedure shall be used as reference for all measurements taken during the test. A vertical load increasing in increments of 2,000 pounds to a maximum of 24,000 pounds at a rate of no less than 100 pounds per minute and no more than 1,000 pounds per minute shall be applied downward at the center of the rail head

midway between RT and SPRT units. For each increment of load, the vertical deflection of the rail head at each RT and SPRT unit shall be measured to the nearest 0.001 inch and shall be recorded. The load shall be removed and the final position of the rail head shall be measured and recorded. The values for vertical loads versus deflection shall be plotted on a graph.

b. The average spring rate of the RT and SPRT units shall be between 85,000 pounds per inch and 150,000 pounds per inch for loads between 4,000 pounds and 12,000 pounds per rail seat. One minute after the removal of the maximum load, the rail head shall return to within 0.05 inch of the reference position. The RT and SPRT components shall not exhibit evidence of failure such as slippage, yielding or fracture.

10. Lateral Load Test

a. Prior to the test, a minimum of ten 14,000 pounds vertical loading cycles shall be applied downward at the center of the rail head midway between the RT and SPRT units to ensure the proper seating of all components. The position of the rail head after the seating procedure shall be used as reference for all measurements taken during the test. A vertical load of 14,000 pounds shall then be applied downward at the center of the rail head midway between the RT and SPRT units. A lateral load, increasing in increments of 1,000 pounds to a maximum load of 6,000 pounds, at a rate of no less than 100 pounds per minute and no more than 1,000 pounds per minute, shall be applied horizontally to the rail head at a point 0.625 inches below the top of the rail midway between RT and SPRT units in a direction normal to the vertical load. The lateral displacement of the rail head shall be continuously measured throughout the loading sequence at a point 0.625 inches below the top of the rail at each RT and SPRT unit. The vertical and lateral loads shall be removed and the final position of the rail head shall be measured at each rail seat and recorded. The recorded values for lateral loads versus displacement shall be plotted on a graph.

b. The lateral displacement of the rail head when fully loaded shall not exceed 0.250 inches from the original gauge line. The difference between the original and final positions of the rail head shall not exceed 0.062 inches. At no time during the test shall a RT and SPRT component exhibit evidence of failure such as slippage, yielding or fracture.

11. Lateral Restraint Test

a. A static vertical load of 5,000 pounds shall be applied to the rail head midway between the RT and SPRT units. A lateral load shall then be applied at the base of the rail normal to the vertical load midway between the RT and SPRT units increasing in increments of 500 pounds from zero to 14,000 pounds at a rate of no less than 100 pounds per minute and no more than 500 pounds per minute. The lateral displacement of the rail head and rail base at each RT and SPRT unit shall be measured to the nearest 0.001 inch and shall be recorded after each increment of loading.

b. The lateral displacement of the rail head when fully loaded shall not exceed 0.125 inch from the original gauge line and the lateral displacement of the rail base shall not exceed 0.010 inch from the original gauge line. At no time during the test shall a component exhibit evidence of failure such as slippage, yielding or fracture.

12. Longitudinal Restraint Test

a. A load shall be applied longitudinally to the rail at its base increasing in increments of 500 pounds at a rate of no less than 100 pounds per minute and no more than 500 pounds per minute. Load increments shall be maintained constant for at least one minute before increasing the load to the next increment. The load shall be increased in these increments until slippage occurs between the RT and SPRT units and the rail. The longitudinal displacement of the rail shall be measured relative to the RT and SPRT unit nearest the load application point and recorded continuously to the nearest 0.001 inch from the time of initial loading, through rail slippage, to the time of rail unloading. The values for longitudinal load versus displacement shall be plotted on a graph.

b. The longitudinal load at slippage shall be equal to or greater than 5000 pounds. At no time during the test shall a RT and SPRT component exhibit evidence of failure such as slippage, yielding or fracture except for the slippage between the rail fastenings and the rail.

13. Vertical and Lateral Repeated Load Test

a. A vertical load shall be applied to the rail head midway between RT and SPRT units to produce a vertical downward load of 20,000 pounds. A lateral load shall be applied to the gauge side of the rail head midway between RT and SPRT units to produce a load normal to the vertical load of 8,000 pounds. A second lateral load shall be applied to the field side of the rail head midway between RT and SPRT units to produce a load normal to the vertical load of 5,000 pounds. The lateral loads shall be applied 0.625 inch below the top of the rail. Three million cycles of vertical and gauge side lateral loading shall be applied first. Then three million cycles of vertical and field side lateral loading shall be applied. The load cycle frequency shall be regulated to prevent the temperature of the components from exceeding 160 degrees F.

b. The RT and SPRT units shall withstand three million cycles of load application in each direction with no evidence of failure. Upon visual inspection, no component of the RT and SPRT units shall exhibit evidence of failure such as slippage, yielding, abrasion, or fracture during the test. Unacceptable elastomer degradation is defined as the inability of the RT and SPRT unit to meet the post fatigue tests outlined in the qualification test matrix Table 1. Adjusting or tightening of components shall not be permitted at any time during the test.

14. Voltage Withstand Test

a. The concrete slab shall be grounded. A direct current potential of 15 kV (or as high as achievable with the testing equipment if built-in safety features

do not permit to reach 15 kV) shall then be applied to the rail head for one minute.

b. The elastomers shall withstand this test with no visible damage such as splits, cracks, pinholes or fracture.

15. Electrical Resistance and Impedance Tests

a. The concrete slab shall be grounded. A current potential of 750 volts DC shall be applied to the rail head for three minutes. The resistance shall be measured with an accuracy of plus or minus two percent.

b. The rail pad and insulators shall be removed from the assembled test configuration and immersed in distilled water for 70 hours at 95 degrees F. After removal from the water immersion, without drying, and with no portion of the soaked materials or RT and SPRT units at a temperature below 95 degrees F, the soaked materials shall be reinstalled. With the concrete slab grounded, 750 volts DC shall be applied to the rail head for three minutes. A potential of 50 volts AC shall then be applied to the rail head for three minutes for each increment of measurement for frequencies from 20 Hz to 10 kHz, in increments of 20 Hz up to 100 Hz, 200 Hz up to 1,000 Hz, and 2,000 Hz up to 10 kHz. The calculated impedance shall be based on plus or minus two percent accuracy and recorded for each frequency increment.

c. The minimum resistance for 750 volts DC shall be 10 megohms when dry and 1 megohm when wet. The minimum impedance for any frequency between 20 Hz and 10 kHz with 50 volts AC shall be 10,000 ohms.

16. Rail Fastening Uplift Test

a. The configuration for the rail fastening uplift test is a single RT and SPRT unit rigidly restrained from uplift displacement with a rail section fully fastened to the RT and SPRT unit in accordance with the contractor's installation instructions. The rail fastenings from the second RT and SPRT unit shall be removed. The load application point on the rail shall be centered between the installed rail fastenings in a manner that will produce uniform loading to each fastening. An uplift load of 2,000 pounds plus the weight of the rail used in the test assembly shall be applied to the rail perpendicular to the rail seat. The displacement of the rail relative to the RT and SPRT unit shall be measured continuously from initiation of loading through maximum loading to the full release of loading. Without resetting (i.e. without re-zeroing) the deflection measurement, the uplift load and release shall be repeated five times.

b. The position of all components after release of load shall be within the tolerances stated on the shop drawings. The rail fastening components shall not permanently deform. The difference in uplift displacement at 2,000 pounds between any one of the five repetitions of loading and the average total displacement of all repetitions shall not be greater than + 5% of the average total displacement. At no time during the test shall any RT and SPRT component exhibit evidence of failure such as slippage, yielding or fracture.

17. Tests Performed on Individual RT and SPRT Components

    a. Reinforced Concrete Blocks

        1) The contractor shall produce eight test cylinders from a single pour of concrete used in the manufacture of the concrete blocks. The vibration of the casting machine or a vibrating table shall be used to compact the concrete in the moulds. The moulds shall be moist cured from the time of molding until the moment of test. The curing of the concrete cylinders shall be performed in accordance with ASTM C192/C192M or other equivalent specification. Four test cylinders shall be tested at seven days, two for compressive strength and two for flexural strength. If applicable four test cylinders shall be tested at or beyond 28 days, two for compressive strength and two for flexural strength. The flexural strength test shall be executed in accordance with ASTM C78 (beams) or other equivalent specification.

        2) Compressive strength, Fc = 7000 psi

        3) Flexural strength, Ft = 700 psi

18. Concrete block tests

    a. The contractor shall submit three concrete blocks of each type to the tests specified below.

    b. The dimensional tolerances shall conform to the approved shop drawings when measured with instruments or go/no go gauges as stipulated in the approved technical specifications.

    c. The concrete block shall be visually inspected for cracks, structural defects and surface finish.

    d. The concrete block shall not present cracks, structural defects, or surface finish defects incompatible with the satisfactory long term performance of the system.

19. Rail Fastening Tests shall not be performed before 28 days or a 7000 psi concrete compressive strength is achieved, whichever is sooner. The rail fastenings shall be subjected to the pull-out and torque tests described in AREMA.

20. Positive Bending Moment Test

    a. This test shall not be performed before 28 days or a 7000 psi concrete compressive strength is achieved, whichever is sooner.

    b. The configuration for the positive bending moment test shall be as shown in Figure 3.

    c. The objective of this test shall be to record the load required to produce the first crack in the concrete block, and to evaluate the reinforcements' effectiveness in closing the cracks after the removal of the load.

d. Levels P1 and P2 The concrete block shall be positioned under the press actuator and subjected to an initial load of 20,000 pounds.

e. The loading of the concrete block shall be progressively increased by 4000 pounds increments. After each increment, the load shall be maintained for a minimum of one minute while both side surfaces of the concrete block are examined for the presence of cracks.

f. P1 shall be defined as the load required to generate the first crack.

g. After P1 has been reached, the concrete block shall be subjected to successive zero-to-peak loading cycles. The peak load of each cycle shall be increased by a 4000 pounds increment.

h. In each cycle, the load shall be gradually increased from zero up to the peak load. The peak load shall be held for a minimum of one minute before being fully released.

i. Once the load has been released, the width of the cracks on the side surfaces of the unloaded concrete block shall be measured and recorded.

j. The crack widths shall be measured at the level corresponding to the theoretical position of the lower reinforcement's centroid. If it is not possible to measure a crack at this level due to chipping of the concrete or surface imperfections, measurements shall be taken equidistant and as close as possible above and below this level; the two values shall be averaged to obtain the width of the crack.

k. P2 shall be defined as the peak load of the last cycle in which the widest crack on the concrete block is closed after the removal of the load. A crack whose width does not exceed 0.002 inch shall be considered to be closed.

l. Levels P3 and P4. After reaching level P2, the incremental loading cycles shall be resumed.

m. P3 shall be defined as the peak load of the last cycle in which the opening of the widest crack on the unloaded concrete block is not greater than 0.02 inch.

n. After reaching level P3, the load shall be gradually increased until the ultimate failure of the rail concrete block.

o. P4 shall be defined as the maximum load carried by the concrete block.

p. Specified values for P2 and P3 are: P2 ³ 40,000 pounds, P3 ³ 60,000 pounds.

21. Block Pads

a. The Contractor shall supply nine block pads of each type for qualification testing. All nine block pads shall be subjected to the aspect, flatness and dimensional controls. Five block pads out of the aforementioned nine shall then be subjected to the static spring rate test followed by the static versus

dynamic spring rate qualification test for two of them, the high and low temperature spring rate qualification test for one of them, the before versus after heat aging spring rate qualification test for another one and the before versus after fatigue spring rate qualification test for the last one.

b. The porosity test shall be performed on two of the remaining four block pads as well as on the block pad subjected to the fatigue spring rate qualification test, both before and after the completion of the fatigue test.

c. The last two block pads shall be subjected to the acoustic stiffness ratio qualification test for one and the ozone test for the other.

22. The test block pad shall be visually inspected and found flawless and clean edged. Small surface defects, such as chips or blisters, shall, however, not constitute cause for rejection.

23. Flatness Control

a. A full block pad shall rest on a flat, level and smooth control surface. A straight, rigid rule shall be laid across the top surface of the pad along its length. The rule shall rest across the pad without compressing it.

b. The flatness shall be controlled at a minimum of three locations: one inch from each edge and at the centerline of the pad. The procedure shall be repeated with the rule placed along the width of the pad. If visible deformations exist in other locations, these locations shall be verified as well in accordance with the same procedure.

c. No gap or pocket between the rule and the top surface of the pad shall exceed 0.02 inch in depth or 0.80 inch in length.

d. The vertical distance measured from the bottom edge of the rule on either side of the pad (lengthwise and widthwise) and the control surface shall be in accordance with the thickness dimension and tolerance specified in the approved drawing of the block pad.

24. The dimensional tolerances shall be in accordance with the approved drawing of the pad.

25. Static Deflection Measurement

a. This test shall be performed at room temperature (68 degree F) on a complete block pad.

b. The loads shall be transmitted to the block pad through a rigid plate. This plate shall be suitably reinforced to guarantee the accuracy of the pad deflection measurements. Prior to the application of a load, the plate shall rest with all its weight on the pad.

c. Gauges, positioned at the corners of the loading plate, shall be used to measure the deflection of the pad.

d. The block pad shall be subjected to ten preloading cycles between 0 and 12,000 pounds. Preloading shall be applied at a rate of 5000 + 1000 lb. per minute and the load shall be maintained for 60 + 15 seconds before unloading. The pad shall remain free from load for 60 + 15 seconds between preloading cycles.

e. The gauges shall be set to zero within 180 + 30 seconds after the last preloading cycle and loading shall begin immediately thereafter.

f. Loading shall be applied at a rate of 5000 + 1000 lb./minute and the deflection shall be measured within 60 + 15 seconds after loading is completed.

g. The pad shall be subjected to a loading of 12,000 pounds. The deflections measured by the gauges shall be recorded.

h. The deflection of the block pad (average of the four readings) shall correspond to: 0.105 inch + 0.012 inches.

26. Spring Rate Qualification Testing

a. Dynamic spring rate

1) The dynamic spring rate at room temperature (68 degrees F) measured under loads cycled between near zero and 12,000 lbs at a frequency of 20 Hz shall not differ from the static spring rate at room temperature as measured according to Static Deflection Measurement herein, by more than 20 percent.

2) The static spring rates measured at 120 degrees F and 15 degrees F shall not differ from the static spring rate measured at 68 degrees F by more than 20 percent under the load specified in Static Deflection Measurement herein.

3) The static spring rate measured at 68 degrees F after an artificial heat aging at 160 degrees F during 72 hours shall not differ from the static spring rate measured before the artificial heat aging in accordance with Static Deflection Measurement herein, by more than 30 percent.

4) The static spring rate measured at 68 degrees F after 3 million fatigue loading cycles between near zero and 12,000 lbs shall not differ from the static spring rate measured before the beginning of the fatigue test in accordance with Static Deflection Measurement herein by more than 20 percent. The cycling rate shall ensure that overheating of the block pad does not occur.

5) Acoustic stiffness ratio test

a) A block pad shall be subjected to the static spring rate test and the load versus deflection curve shall be plotted between 5,000 and 12,000 pounds.

b) The block pad shall then be subjected to incremental preloads between 5,000 and 12,000 lbs and the corresponding acoustic dynamic spring rate shall be recorded in the 50-250 Hz frequency range.

c) The acoustic dynamic spring rates measured under the above preloads at 100 Hz shall be divided by the corresponding static spring rates measured under the same preloads and the resulting average dynamic to static ratio shall not exceed 2.0.

27. Ozone Test

a. The block pad material shall be exposed to 25pphm ozone for 168 hours at 104 degrees F in accordance with ASTM D1149.

b. No cracks shall be apparent under a magnification of 7 after exposure.

28. Porosity Test

a. This test shall be performed at 68 degrees F.

b. The initial weight (P0) of the block pads shall be measured and recorded.

c. The block pad shall be submerged in distilled water and compressed between two flat steel plates until the distance between the steel plates and therefore the thickness of the compressed block pad reaches 2/3 of the initial pad thickness. The block pad shall remain compressed during one minute. The block pad shall then be unloaded and maintained free of load for another minute. This cycle shall be repeated three times before the block pad is removed from the water.

d. The block pad shall be superficially dried and their weight P1 shall be measured and recorded immediately thereafter.

e. The difference between P1 and PO shall not exceed 0.07 ounces for any of the block pads tested.

29. Rubber Boots

a. The Contractor shall submit three rubber boots of each type to the tests specified below.

b. The rubber boot shall be visually inspected and found flawless and clean edged. Small surface defects, such as chips or blisters, shall, however, not constitute cause for rejection.

c. The dimensional tolerances of the rubber boot shall be in accordance with the approved drawing of the boot.

30. Measurement of the Shore A Hardness

a. The Shore A hardness of the boot material shall be measured according to ASTM D2240, indentation hardness of rubber and plastics by means of a durometer. Measurements shall be made at five points on the upper surface of the boot base.

b. The average of the measured Shore A values must fall between 70 and 80.

31. Measurement of the Ultimate Strength and Elongation at Break

a. Twelve samples (six longitudinal and six transversal) shall be cut from the base of the boot according to ASTM D412, method A, die C. The thickness of the samples shall correspond to that of the base of the boot.

b. The ultimate strength and the elongation at break shall be measured on six samples (three longitudinal and three transversal).

c. The remaining six samples (three longitudinal and three transversal) shall be artificially aged according to ASTM D573 for 72 hours in an oven maintained at a temperature of 212 degrees F + 3 degree F. The ultimate tensile strength and the elongation at break shall be measured after cooling the samples at room temperature (+68 degrees F) for not less than sixteen hours.

d. For each set, the median value of the three measures shall be recorded and the values shall meet the following:

1) Minimum tensile strength of the initial section before ageing 1740 psi and 1450 psi after ageing

2) Minimum elongation at break before ageing 250% and 180% after ageing

1.08 TURNOUT PLATE ANCHORAGE ASSEMBLIES QUALIFICATION TESTING

A. Use the testing requirements provided in Section 34 11 37 - Direct Fixation Fasteners, for anchor bolts.

1.09 PACKAGING, LOADING, SHIPPING, AND HANDLING

A. The Contractor shall submit a stockpile plan to the Engineer for approval that defines how resilient ties and fastener components will be stacked and the area required.

B. Resilient ties shall be lifted and supported during manufacture, storage, transportation, loading, unloading, and stockpiling in a way which will prevent chipping, spalling, cracking, or other damage.

C. When resilient ties are stacked in multiple tiers, each tier shall be separated with dunnage having sufficient thickness to clear fastening shoulder inserts.

D. Resilient ties shall be uniformly vertically supported. All dunnage and separators shall in or align with the rail seat area.

E. Resilient ties sets required for special trackwork units shall be packaged separately and each shall be marked with the special trackwork unit identification number, unique color coding and location number. Complete resilient ties sets shall be first sent to the manufacturing facility of the special trackwork, for required complete preassembly prior to shipment to the District.

PART 2 - PRODUCTS

2.01 DISTRICT-FURNISHED MATERIALS

A. Refer to Section 01 64 13 - District-Furnished Materials and Equipment, of the Contract Specifications for description and quantity of District-furnished materials.

2.02 CONTRACTOR-FURNISHED MATERIALS

A. All products, tools, materials, equipment and labor required to complete all aspects of the work shall be furnished by the Contractor.

2.03 RESILIENT TIES

A. RTs and SPRTs shall be steel reinforced concrete fabricated in accordance with domestic industry practice.

B. SPRTs shall also include insulated rail fastenings consisting of embedded cast iron shoulders, drive on spring clips, plastic insulators and pads. Threaded fastener inserts shall be provided for attachment of the switch machine and contact rail or contact rail brackets.

1. Gage plates shall not be used.

2. Location and tolerances of turnout plates and inserts shall be in accordance with the manufacturer's drawings and specifications and shall yield the tolerances provided herein.

3. Third rail insulators support may be directly supported or use standard third rail insulator brackets and shall be provided for every tie along the outside rail of special trackwork, except between the running rail and switch machine.

4. Threaded fastener inserts for switch machines shall be provided shall be the same type required for use for anchor bolts on direct fixation fasteners.

5. Ties supporting switch machines shall be continuous or connected with an integral gage rod between the running rails. In either case the resilient tie shall be one piece between the nearest running rail and the switch machine.

2.04 GENERAL PRODUCTION

A. Manufacture all resilient ties using the same methods used to produce qualification test pieces.

B. Fabrication of the block ties shall conform with applicable requirements of the AREMA Manual, PCI MNL 116, and applicable requirements of Section 03 40 00 - Precast Concrete.

C. Production of resilient ties or components prior to the Engineer's review and approval is prohibited.

2.05 TWO-BLOCK TIE CONCRETE PRODUCTION

A. Concrete Quality:

1. Water content shall be kept to a minimum consistent with the strength requirements and placement needs. Concrete mixes shall be proportioned to produce a compressive strength of at least 7,000 psi when tested at 28 days in accordance with ASTM C39/C39M.

2. The 28 day flexural strength shall be at least 700 psi.

B. Concrete Mix Proportions:

1. Unless previous data are available to show that a concrete mix will be satisfactory for the production of concrete block ties, concrete mix designs shall be established by tests on trial batches to achieve the specified strengths. Mix designs shall be submitted to the Engineer for review and approval.

2. The cement content shall not be less than 660 pounds per cubic yard.

3. Water-cement ratio shall not exceed 0.40 by weight and shall be calculated on the basis of the weight of cement.

4. Trial mixes using aggregate, water, cement, and admixtures proposed for the manufacture of concrete ties shall be made using at least three different water-cement ratios which will produce a range of strengths encompassing those specified herein. For each water-cement ratio, at least three specimens for each age to be tested shall be made, cured, and tested as hereinafter specified.

   a. Compressive strength tests shall be performed at 28 days. A curve shall be established showing the relationship between water-cement ratio and compressive strength. The maximum permissible water-cement ratio for the concrete to be used shall be that shown by the curve to produce average strengths of 110 percent of those specified herein, provided the water-cement ratio shall be no greater than 0.40 when measured by weight.

   b. Flexural strength tests shall be performed at 28 days as specified in Article herein for each trial mix.

5. The proportions of aggregate to cement shall produce a mixture which will work readily into corners and angles of the forms and around the reinforcement with the assistance of specified vibration, but without permitting the materials to segregate or excess free water to collect on the surface.

2.06 RT AND SPRT PRODUCTION TESTING

A. Production testing shall be performed at the manufacturer's laboratory or, if such laboratory is not equipped to perform one or more of the tests specified herein, at a qualified outside laboratory.

B. If all the control and test results specified herein are satisfactory, the daily batch defined as all the concrete blocks of each type produced during one day shall be accepted. Any control or test failure shall cause the daily batch to be rejected.

C. Perform all production testing as provided herein for qualification testing.

D. Concrete Control Tests

1. Produce four test cylinders per production week.

2. Two test cylinders shall be tested at seven days, one for compressive strength and one for flexural strength.

3. Two test cylinders shall be tested at 28 days, one for compressive strength and one for flexural strength.

E Two concrete blocks per daily batch shall be subjected to dimensional control.

F. Production aspect control shall be performed on all concrete blocks.

G. Fastening Tests

1. Perform pull out test shall be performed on one concrete block per daily batch.

2. Torque test shall be performed on one concrete block per daily batch.

H. Positive Bending Moment Test

1. Rail seat positive bending moment test shall be performed on one concrete block per daily batch.

2. Every concrete block subjected to this test shall be tested up to level P2.

3. Only every tenth concrete block subjected to this test shall be tested up to level P4.

I. Block Pads

1. Unless otherwise agreed by the Engineer, batches of block pads shall not exceed 3000 units of standard plain line block pads and 300 units of all other types of block pads per batch when presented for inspection.

2. Three block pads per batch shall be randomly selected for each production control and test specified herein.

3. If the three control and test results are satisfactory, the batch shall be accepted.

4. If one result does not meet the requirements, the control or test shall be repeated on six additional randomly selected block pads.

5. If more than one of the first three or any of the additional six block pads do not meet the requirements, the batch shall be rejected.

6. The manufacturer shall, however, have the option to subdivide a rejected batch into 500 unit sub-batches and to repeat the controls and tests on each sub-batch using the same acceptance and rejection criteria as above.

7. The following controls and tests shall be performed as indicated herein.

   a. Aspect Control.

   b. Flatness Control.

   c. Dimensional Control.

   d. Static Deflection Measurement.

   e. Porosity Measurements.

J. Rubber Boots

1. Unless otherwise agreed by the Engineer, batches of rubber boots shall not exceed 3000 units of standard plain line rubber boots and 300 units of all other types of rubber boots per batch when presented for inspection.

2. Three rubber boots per batch shall be randomly selected for testing.

3. If the three test results are satisfactory, the batch shall be accepted.

4. If one result does not meet the requirements, the test shall be repeated on six additional randomly selected rubber boots.

5. If more than one of the first three or any of the additional six rubber boots do not meet the requirements, the batch shall be rejected.

6. The manufacturer shall, however, have the option to subdivide a rejected batch into 500 unit sub-batches and to repeat the tests on each sub-batch using the same acceptance and rejection criteria as above.

7. The following controls and tests shall be performed as indicated herein.

   a. Aspect Control.

   b. Measurement of the Shore A Hardness.

   c. Dimensional Control.

   d. Static Deflection Measurement.

   e. Measurement of the Ultimate Strength and Elongation at Break.

PART 3 - EXECUTION

3.01 INSTALLATION

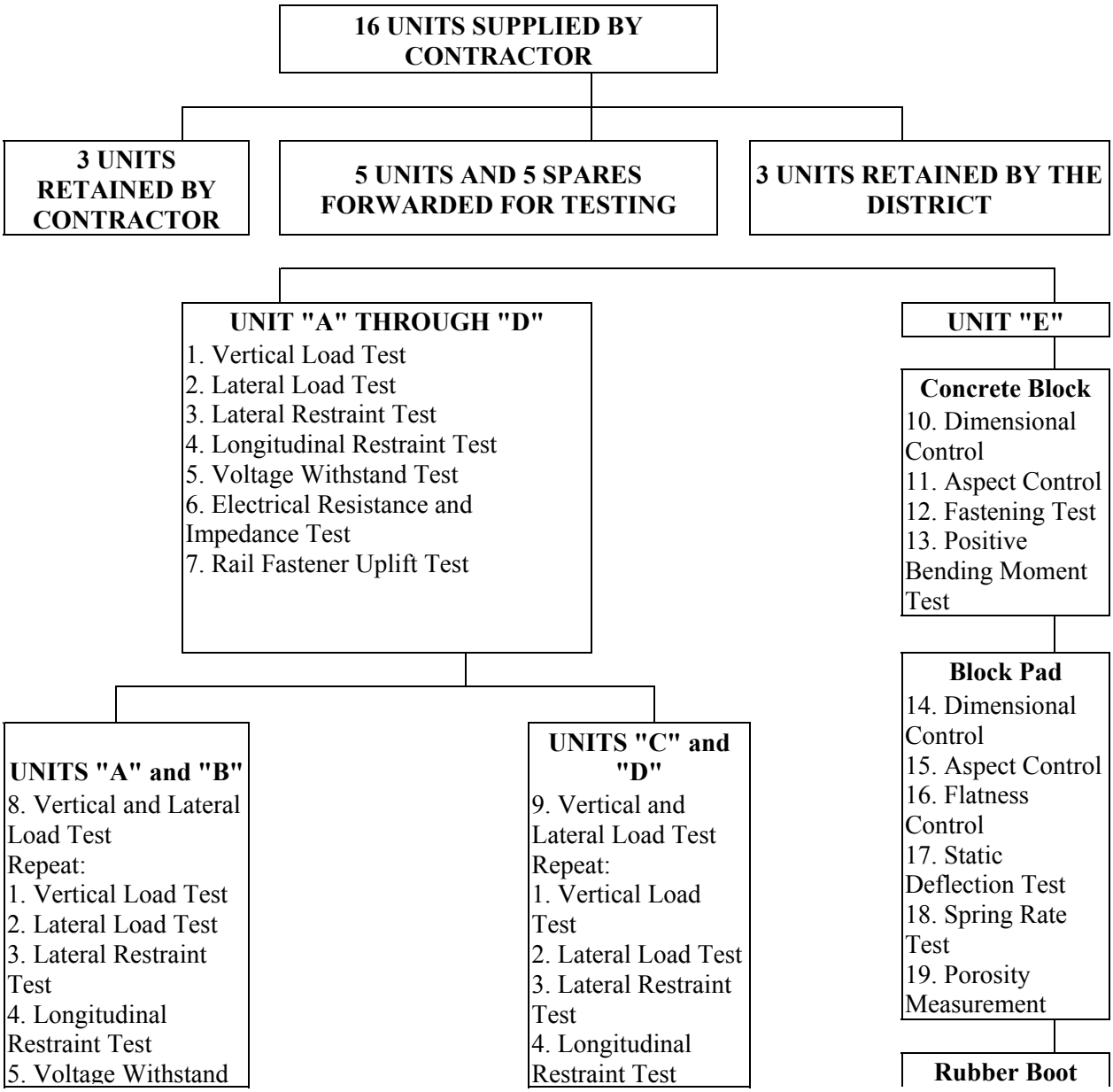
A. Install resilient ties in accordance with the respective manufacturer's recommended installation instructions and procedures and as provided, except as modified herein.

B. Install resilient ties in accordance with the requirements of Section 34 05 17 - Common Work Results for Trackway.

END OF SECTION 34 11 32

FIGURE 1 – RT AND SPRT QUALIFICATION TESTING SEQUENCE

PART A - RT AND SPRT UNITS



5. Voltage Withstand Test 6. Electrical Resistance and Impedance Test 7. Rail Fastener Uplift Test	Restraint Test 5. Voltage Withstand Test 6. Electrical Resistance and Impedance Test 7. Rail Fastener Uplift Test	20. Dimensional Control 21. Aspect Control 22. Shore A Hardness 23. Ultimate Strength and Elongation

PART B - CONCRETE CYCLINDERS OR CORE

8 CYCLINDERS OR CORES SUPPLIED BY CONTRACTOR

4 UNITS 24. Compressive Strength Test 25. Flexural Strength Test	**4 UNITS RETAINED BY CONTRACTOR AS SPARES**

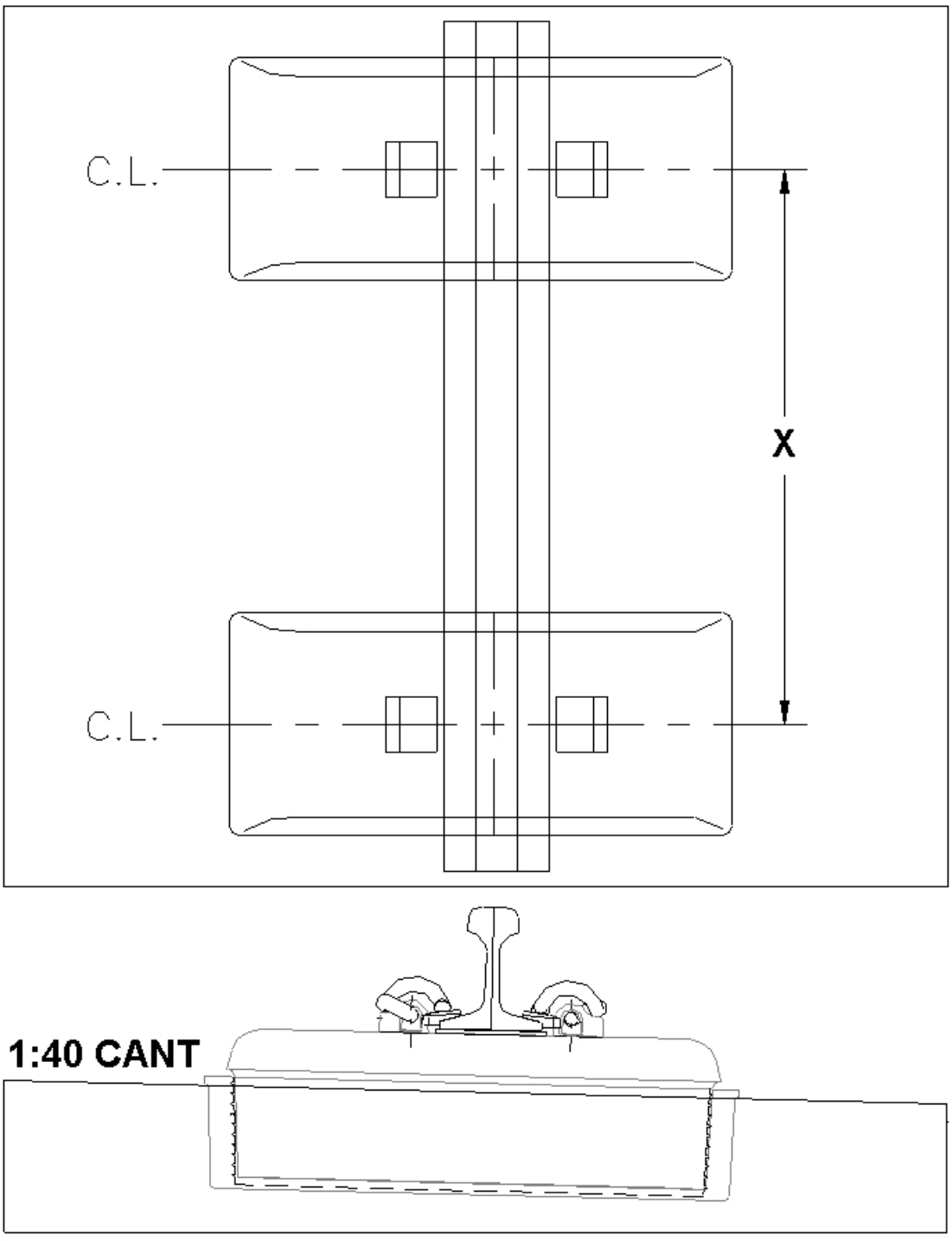


FIGURE 2 – REILIENT TIE TEST ASSEMBLY

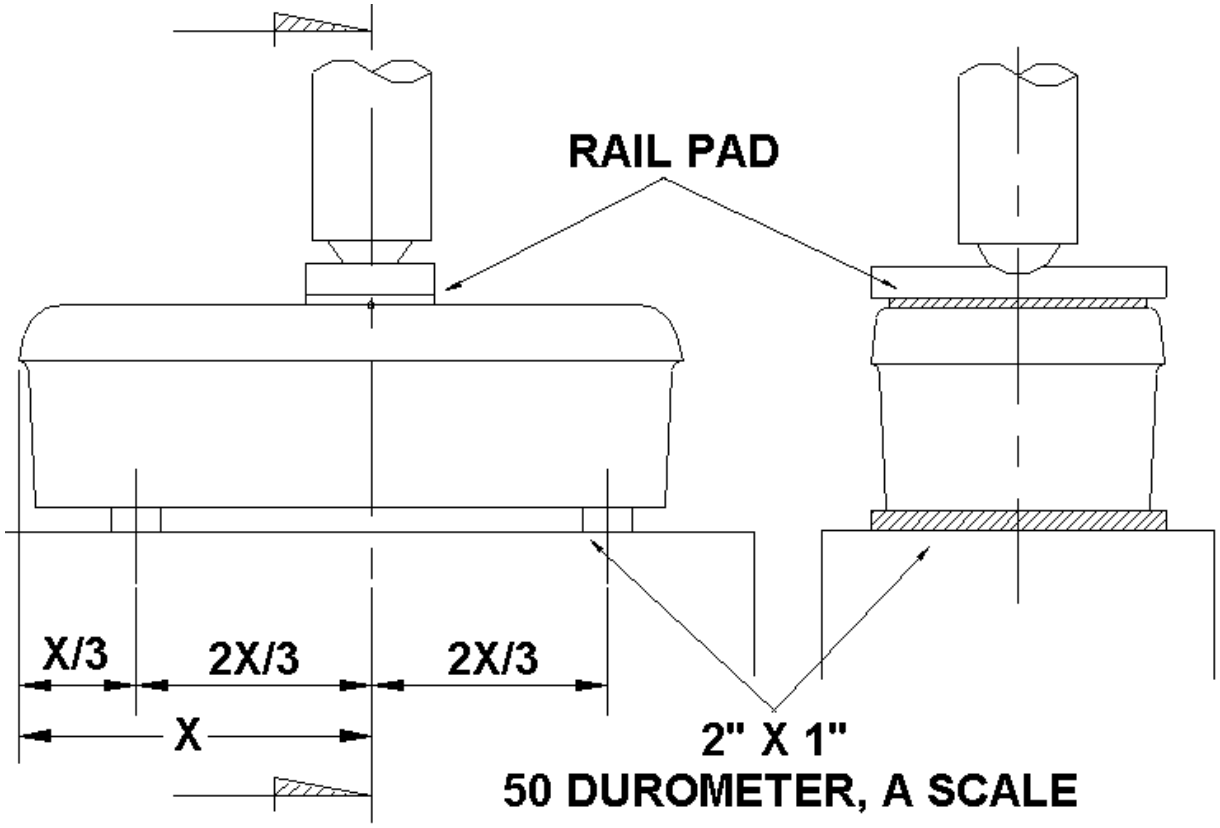


FIGURE 3 – RESILIENT TIE POSITIVE BENDING MOMENT TEST